This Page Is Inserted by IFW Operations
and is not a part of the Official Record

BEST AVAILABLE IMAGES

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

IMAGES ARE BEST AVAILABLE COPY.

As rescanning documents *will not* correct images, please do not report the images to the Image Problem Mailbox.

The Patent Office

09/911624

INVESTOR IN PEOPLE

GB00/763

REC'D 10 APR 2000

WIPO PCT

The Patent Office
Concept House
Cardiff Road
Newport
South Wales
NP10 8QQ

PRIORITY DOCUMENT

SUBMITTED OR TRANSMITTED IN COMPLIANCE WITH RULE 17.1(a) OR (b)

I, the undersigned, being an officer duly authorised in accordance with Section 74(1) and (4) of the Deregulation & Contracting Out Act 1994, to sign and issue certificates on behalf of the Comptroller-General, hereby certify that annexed hereto is a true copy of the documents as originally filed in connection with the patent application identified therein.

In accordance with the Patents (Companies Re-registration) Rules 1982, if a company named in this certificate and any accompanying documents has re-registered under the Companies Act 1980 with the same name as that with which it was registered immediately before re-registration save for the substitution as, or inclusion as, the last part of the name of the words "public limited company" or their equivalents in Welsh, references to the name of the company in this certificate and any accompanying documents shall be treated as references to the name with which it is so re-registered.

In accordance with the rules, the words "public limited company" may be replaced by p.l.c., plc, P.L.C. or PLC.

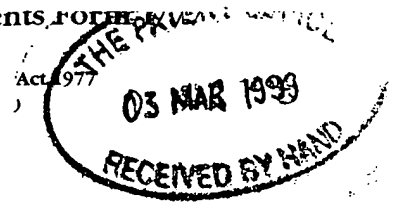
Re-registration under the Companies Act does not constitute a new legal entity but merely subjects the company to certain additional company law rules.

Signed R. Mahoney

Dated 22nd March 2000

Patents Form 1/77

Act 1977



The Patent Office

03MAR99 E429963-1 D00034
7700 0.00 9904914.0

Request for grant of a patent

(See the notes on the back of this form. You can also get an explanatory leaflet from the Patent Office to help you fill in this form)

The Patent Office

Cardiff Road
Newport
Gwent NP9 1RH

1. Your reference

P13828

2. Patent application number
(The Patent Office will fill in this part)

9904914.0

3. Full name, address and postcode of the or of each applicant *(underline all surnames)*

BHR GROUP LIMITED
THE FLUID ENGINEERING CENTRE
CRANFIELD
BEDFORD MK43 0AJ

Patents ADP number *(if you know it)*

If the applicant is a corporate body, give the country/state of its incorporation

5802017002

4. Title of the invention

FLUID SUPPLY SYSTEM

5. Name of your agent *(if you have one)*

"Address for service" in the United Kingdom to which all correspondence should be sent *(including the postcode)*

Edward Evans & Co.,
Chancery House
Chancery Lane
London WC2A 1SD

Patents ADP number *(if you know it)*

66101

6. If you are declaring priority from one or more earlier patent applications, give the country and the date of filing of the or of each of these earlier applications and *(if you know it)* the or each application number

Country	Priority application number *(if you know it)*	Date of filing *(day / month / year)*

7. If this application is divided or otherwise derived from an earlier UK application, give the number and the filing date of the earlier application

Number of earlier application	Date of filing *(day / month / year)*

8. Is a statement of inventorship and of right to grant of a patent required in support of this request? *(Answer 'Yes' if:*

a) any applicant named in part 3 is not an inventor, or
b) there is an inventor who is not named as an applicant, or
c) any named applicant is a corporate body.
See note (d))

Yes

Patents Form 1/77

9. Enter the number of sheets for any of the following items you are filing with this form. Do not count copies of the same document

Continuation sheets of this form	
Description	11
Claim(s)	2
Abstract	1
Drawing(s)	5 + 5

10. If you are also filing any of the following, state how many against each item.

Priority documents	
Translations of priority documents	
Statement of inventorship and right to grant of a patent *(Patents Form 7/77)*	
Request for preliminary examination and search *(Patents Form 9/77)*	
Request for substantive examination *(Patents Form 10/77)*	
Any other documents *(please specify)*	

11. I/We request the grant of a patent on the basis of this application.

Signature [signature] Date 3 March 1999

12. Name and daytime telephone number of person to contact in the United Kingdom: Mark C. Foster 0171 405 4916

Warning

After an application for a patent has been filed, the Comptroller of the Patent Office will consider whether publication or communication of the invention should be prohibited or restricted under Section 22 of the Patents Act 1977. You will be informed if it is necessary to prohibit or restrict your invention in this way. Furthermore, if you live in the United Kingdom, Section 23 of the Patents Act 1977 stops you from applying for a patent abroad without first getting written permission from the Patent Office unless an application has been filed at least 6 weeks beforehand in the United Kingdom for a patent for the same invention and either no direction prohibiting publication or communication has been given, or any such direction has been revoked.

Notes

a) If you need help to fill in this form or you have any questions, please contact the Patent Office on 0645 500505.

b) Write your answers in capital letters using black ink or you may type them.

c) If there is not enough space for all the relevant details on any part of this form, please continue on a separate sheet of paper and write "see continuation sheet" in the relevant part(s). Any continuation sheet should be attached to this form.

d) If you have answered 'Yes' Patents Form 7/77 will need to be filed.

e) Once you have filled in the form you must remember to sign and date it.

f) For details of the fee and ways to pay please contact the Patent Office.

FLUID SUPPLY SYSTEM

Flow control in fluid supply systems is often achieved by valves. Valves can be damaged by some fluids or matter entrained by the fluids. It is the purpose of the present invention to provide a fluid supply system with a control valve arranged so that it is not damaged in the manner described above.

According to the invention there is provided a fluid supply system comprising a supply of clean fluid under pressure connected to an entrainment vessel in which the clean fluid can take up another component, an outlet from the container leading to a system outlet and a jet pump having a high pressure inlet, a lower pressure inlet and an outlet, the supply of pressurised clean fluid passing from the high pressure inlet to the low pressure inlet of the jet pump en route for the inlet of the entrainment container and the outlet of the jet pump being connected through a valve to a junction between the outlet of the entrainment vessel and the system outlet. When the valve is closed, the jet pump simply provides a conduit between its high pressure inlet and low pressure inlet and the fluid flows through that conduit, then through the vessel and thence to the system outlet. When the valve is open, the jet pump operates as such and reverses the pressure differential between the inlet and outlet of the vessel so that fluid is drawn out of the inlet of the vessel into the jet pump, through the valve and back to the vessel through its outlet. Since clean fluid has, up to the time the valve was opened, been supplied to the inlet of the vessel and the majority of the fluid passing through the outlet of the jet pump when it operates as such is clean fluid from the high pressure inlet, the valve receives substantially clean fluid and so is not damaged by any other components in the system. Furthermore, any other components in the conduits downstream of the vessel in its normal operating

mode are drained back into the vessel and so do not stagnate in the system downstream of the vessel.

The effect of opening the valve is to reduce the supply of other components in the fluid reaching the system outlet but some fluid will still be supplied. If it is desired to cut off the supply of fluid to the system outlet completely, then a further valve should be provided downstream of the junction between the conduits from the valve and the outlet of the vessel. If this valve is operated during normal flow of the system (with the jet pump valve closed), it will have to operate while carrying the other components in the fluid flow. Any damage to the further valve can be alleviated by providing it with a flushing system, for example connected to the supply of clean fluid, valves in the flushing system being opened before the further valve is closed in order to flush out other components from this valve. The presence of other components in the further valve can be reduced by first opening the jet pump valve.

As a subsidiary feature of the invention defined above, or as an independent feature, a fluid transfer system can be provided from a first container to a second, comprising a first pump and a jet pump, the pump taking fluid from the second container and feeding it under pressure to the high pressure inlet of the jet pump, the low pressure inlet of the jet pump being connected to the first container and the outlet of the jet pump being connected to the second container. The suction of the first pump makes room in the second container, the first pump drives the jet pump and the jet pump makes the transfer. The fluid in its transfer path from the first container to the second does not pass through the first pump, which is thereby protected from any damage which could be caused by such passage.

Examples of the invention will now be described with reference to the accompanying drawings in which:

Figure 1 shows an abrasive mixture dispensing apparatus,

Figure 2 shows a discharge vessel and its associated filling reservoir,

Figure 3 shows an alternative system to that of Figure 2,

Figure 4 is a diagram of the interior of the discharge vessel of Figure 1,

Figure 5 shows an alternative arrangement to that of Figure 4 where a filter has replaced the valve arrangement,

Figure 6 shows the filter arrangement of Figure 5 for use with coaxial conduits,

Figures 7a and 7b show alternative arrangements of conduits connected to the pressure vessel and

Figure 8 shows an alternative dispensing system.

Carrier fluid in the form of water is supplied from a water feed tank 31 by means of a pump 32 through a flexible module connection hose 33 to a slurry module 34. The inlet to the slurry module 34 has a non-return valve 35 and an emergency depressurisation valve 36. A pressure gauge 37 and a relief valve 38 are also connected downstream of the non-return valve.

Abrasive material is introduced into the carrier fluid from a refill unit 41 which is connected to a discharge vessel 1 by means of a pair of conduits 7 and 8, shown in greater detail in Figure 2. A pump 14 in conduit 7 pressurises the top of the refillable reservoir 41 containing an abrasive mixture, so that abrasive mixture is forced through the conduit 8 to the vessel 1. A filter 10 is located on the entry to the conduit 8 so as to stop the flow when the vessel 1 is filled with abrasive. The pump 14 may be sensitive to the flow reduction and thus switch off.

Figure 3 shows an alternative arrangement where the direct connection of the pump 14 to handle the flow of fluid from vessel 1 to reservoir 41 is replaced by an indirect connection. In Figure 3, the pump 14 takes fluid from a filtered exit from the reservoir 41 and feeds the high pressure inlet of a jet pump 15. The low pressure inlet of the pump 15 comes from the filtered exit port of the vessel 1 and the jet pump outlet is connected to the top of the reservoir 41. In this way, the pump 14 is better isolated from any abrasive which may pass through the filter 10 from the vessel 1.

The two conduits 7 and 8 are controlled by a valve assembly including a valve member 2 (see Figure 4) which can be moved by means of a lever 3 pivoted about a shaft 5 carried in bearings 4 in the upper face of the discharge vessel 1 between an operative position in which it closes at the two conduits 7 and 8 and an inoperative position in which the two conduits 7 and 8 are open. The valve member 2 is located in the interior of the discharge vessel 1. It controls the two conduits in a compact manner, which is important when the discharge vessel has to withstand high pressures of the order of 400 MPa when the internal volume may be only 20% of its exterior volume.

Although the conduits 7 and 8 are shown diagrammatically in Figure 4 side by side, they may be arranged in a variety of relative positions. Figure 7a shows the two conduits ending in semicircles with a common diameter boundary wall. The valve member 2 is circular and can be moved by the lever 3 from the position shown in Figure 7a in full lines, the inoperative position, to the position shown in dotted lines, the operative position, in which the valve member 2 is aligned with the circle formed by the two conduits 7 and 8 and fully closes them.

Figure 7b shows an alternative arrangement in which the conduit 7 is arranged coaxially within the conduit 8 and both conduits will be closed by the valve member 2 when in the operative position shown in dotted lines in Figure 7b. The two conduits 7, 8 could be mutually spaced, provided that the valve member 2 is large enough to close them both in the operative position, but arranging the two conduits in a single penetration of the pressure vessel wall reduces the stress loadings in that wall, important at high pressures.

When the vessel 1 is used for making an abrasive mixture of carrier fluid and abrasive particles, passage through the conduit 8 can be controlled by a filter 10 rather than the valve 2 to prevent particles in the vessel 1 escaping through the conduit 8. Figure 6 shows the filter in position and Figure 5 shows the filter 10 encircling a tapering coaxial channel leading from the conduit 7 in the coaxial conduit arrangement already described with reference to Figure 7b.

Figure 6 shows the filter 10 in position below conduit 8 in a discharge vessel 1. Conduit 7 is connected by a diffuser 11 to a spreader 12 which together reduce the velocity of the mixture entering the vessel 1 through conduit 7 and carries it away from the conduit 8. When the velocity of the fluid entering the vessel has been reduced, abrasive particles in the entering mixture will drop to the bottom of the vessel and the carrier liquid can be withdrawn through the conduit 8, the filter 10 helping to remove any abrasive particles still entrained in the carrier liquid. It may be arranged that the diffuser 11 and filter 10 are movable with the valve member 2 (when both filter 10 and valve member are present) so that they are aligned with the conduits 7 and 8 when the valve member 2 leaves these conduits open.

Besides the conduits 7 and 8, a further conduit 6 extends from the top of the vessel 1. Conduit 6 leads to the low pressure inlet 63 of the jet pump 61 in Figure 1. The conduit 6 may be arranged to that it is closed by an additional valve member not shown when the valve 2 is in its inoperative position, and is opened when the valve is in its operative position, so that the conduit 6 is opened when the conduits 7 and 8 are closed and vice versa. With this arrangement, and a suitably directed nozzle connected to the conduit 6, it may be arranged that the filter 10 is cleaned by fluid entering the conduit 6 when the conduits 7 and 8 are closed.

Although the conduits 7 and 8 are close together, the kinetic energy of the abrasive mixture entering the vessel 1 through conduit 7 is such that fluid will not pass directly to the conduit 8, but only after it has lost velocity and moved away from the conduit 8 to deposit the abrasive particles within the container. This arrangement within the discharge vessel therefore serves to strip the incoming fluid of its abrasive particles before returning the stripped fluid through the conduit 8. To prevent abrasive particles becoming trapped between the valve member 2 and the mouth of the conduits 7 and 8, the lever 3 is preferably spring-loaded so as to bias the valve member 2 against the mouths of conduits 7 and 8 and the surrounding internal surface of the vessel.

In normal operation of the apparatus of Figure 1, the abrasive mixture is fed from the part of the discharge vessel remote 1 from the transfer valve 2 through a discharge tube 51 controlled by a restrictor 57 which tube 51 is joined to the outlet of the non-return valve 35 in the slurry module, the combined flow being connected by means of an isolation valve 52 through a flexible discharge hose 53 to a system outlet nozzle 54 which applies the abrasive mixture to the workpiece. The flow of abrasive

mixture from the discharge vessel is controlled by means of a valve 65 and a jet pump 61 which has a high pressure inlet 62, a low pressure inlet 63 and an outlet 64. The high pressure inlet 62 is connected to the outlet of the non-return valve 35 and the low pressure inlet 63 is connected to the conduit 6 of the discharge vessel 1. The outlet is connected through the valve 65 to the direct line from the outlet of the non-return valve which line contains an adjustable restriction 66. When this last-mentioned valve 65 is closed, carrier fluid flows through the jet pump from the high pressure inlet 62 to the low pressure inlet 63 and then through the discharge vessel 1 where it entrains the abrasive mixture therein and causes it to flow through the discharge tube 51 and the isolation valve 52 to the nozzle 54. The restriction 66 is adjusted to mix plain carrier fluid with the abrasive mixture from the tube 51 to control the concentration of abrasive reaching the nozzle 54.

The valve 52 can be closed to stop the flow to the nozzle 54 when valve 65 is closed, and to stop air being drawn into the system through the nozzle when valve 65 is open. In applications where it is necessary rapidly to stop and start discharge, valve 52 has to operate under pressure. In order to prevent abrasive wear a ball valve is used for valve 52, with the same size bore as its inlet and outlet pipes. Ball valves are not suitable for on/off operations with large pressure differentials. Also micron and sub-micron particles can enter the clearances between a ball and its seats. Under high loading during valved operation particles can become embedded in the sliding surfaces and lead to rapid wear. During ball rotation particles can also enter the space between the ball and its housing. A valve 55, which only sees clean water, is used to provide a by-pass around valve 52. The by-pass circuit 56 leading from the clean water supply from the valve 35 provides a flushing flow between the ball in valve 52 and

its housing in order to flush abrasive particles from the cavity between the ball and its housing and to provide a flow of water from the cavity to the valve outlet, as the bore in the ball cross-connects between the cavity and the valve's outlet.

When it is required to stop flow at the nozzle, valve 65 is opened and, after a brief delay to clear abrasive from the pipework to valve 52, valve 55 is opened to flush out valve 52; then valve 52 can be closed without a large pressure differential followed by valve 55 to stop flow at the nozzle. When the valve 65 is open, the jet pump action is started and the flow through the low pressure inlet of the jet pump is reversed from that already described, so that the flow through the discharge tube 51, the discharge vessel 1 and the low pressure inlet 63 to the jet pump is reversed. This clears the discharge tube 51 of any abrasive mixture and prevents the formation of a plug of abrasive material therein which might hinder subsequent operation of the apparatus. The constriction 57 on the end of tube 51 discourages the continued flow of abrasive upwards through the tube 51 when valve 65 is opened which might leave a slug of abrasive in the tube 51. The escape route via 63, 64 and 65 is of less resistance than the route through the two constrictions 62 and 66. When the valve 52 is closed, carrier fluid flows down the tube 51 to clear any compaction of abrasive particles which may have occurred in the vessel 1 due to interparticle forces and to provide flow passages in the particle bed.

When it is desired to supply the abrasive mixture to the nozzle again, the valve 65 is closed, the jet pump action stops and the carrier fluid simply flows between the inlets of the jet pump to entrain the abrasive mixture in the discharge vessel and transfer it through the discharge tube to the nozzle, as already described.

When the whole apparatus has been at rest, the valve 65 associated with the jet pump is initially opened in order that the initial flow through the discharge tube is downwards back into the discharge vessel, again to clear any plug of abrasive material which may have formed. After this start-up procedure, the valve 65 is closed and the jet pump action ceases.

Various methods can be used for refilling the vessel 1 with abrasive mixture. One such method has been described in EP-A-276 219. Figures 1 and 2 illustrate the use of a single discharge vessel 1; Figure 8 illustrates the use of a pair of discharge vessels. In Figure 2, the hand pump 14 is operated to cause the flow of abrasive mixture through the refill unit 41 and the conduits 7 and 8 of discharge vessel 1 in a circulating path. The abrasive material in the mixture passes into the discharge vessel and the material sinks under gravity towards the bottom of the discharge vessel, leaving the carrier fluid part of the mixture to return through the transfer valve and the hand pump back to the remote end of the refill unit. By this operation, abrasive material is transferred from the refill unit to the discharge vessel until the refill unit is exhausted of abrasive material, after which the transfer valve is closed and the refill unit can be replaced or recharged. Provided that an adequate concentration of abrasive material is maintained in the discharge vessel 1, the transfer of abrasive material from refill units to the discharge vessel can continue in batches while the abrasive mixture is continuously discharged from the nozzle. Only if the concentration of the abrasive mixture falls below the desired level or the use of the abrasive mixture at the nozzle is temporarily not required is the jet pump valve opened to stop the supply of abrasive mixture to the nozzle.

Figure 8 shows the twin discharge vessel system.

Instead of having conduits 7 and 8 in vessel 1 through which an abrasive mixture can be circulated, such conduits 7 and 8 are provided in a separate pressure vessel 70 and the separate pressure vessel 70 is arranged to transfer fluidised abrasive mixture to the main pressure vessel 1. This makes it easier for a continuous supply of abrasive mixture to be fed from the main pressure vessel through the tube 51. The vessel 70 is provided with inlet and outlet conduits 7 and 8 connected through valves 71 and 72 to a refill unit 41 which operates in the same way as described above with reference to Figure 1 and will not be further described. A connection is made from the outlet conduit 64 of the jet pump through a valve 79 to the outlet conduit 8 of the separate pressure vessel 70. A depressurisation valve 81 and depressurisation orifice 82 are connected between the valve 79 and the outlet conduit 8. The outlet conduit 76 from the separate pressure vessel 70 is connected through a valve 80 to the inlet conduit 7 of the main pressure vessel 1 and a connection is made as shown in Figure 8 between the outlet of the one-way valve 35 and the junction between the valve 80 and the separate pressure vessel 70 through a valve 74, filter 75 and orifice 83.

The apparatus of Figure 8 operates to supply abrasive mixture to the nozzle as described above with reference to Figure 1. The valve 52 is open and the valve 65 closed, clean fluid passing through the conduits 62 and 63 of the jet pump into the pressure vessel 1 and abrasive mixture is forced out through the conduit 51. As the abrasive mixture in the vessel 1 becomes low, the valves 65 and 79 are both opened so that the jet pump operates as such and pumps clean fluid through the valve 79 to fluidise an abrasive mixture which has already been introduced into the separate vessel 70 by the hand pump associated with the refill unit 14 connected thereto. Abrasive mixture is thus forced through the conduit 76 and valve 80 into the main pressure vessel 1, induced by the suction towards the conduit 63

created by the operation of the jet pump. Abrasive mixture thus continues to leave the main pressure vessel 1 through conduit 51 and provided that the rate of introduction of abrasive mixture through the valve 80 is greater than the rate of its leaving through the conduit 51, the main pressure vessel 1 will be refilled with abrasive mixture. Once it is so refilled, the valves 65 and 79 are closed so that normal operation of the main system as described with reference to Figure 1 continues. The valve 81 is then opened to reduce the pressure in the separate vessel 70 which can then be refilled from the reservoir 41 as already described. The valve 74 can be opened to flush out the connection between the vessels 70 and 1 and after the seat of the valve 80 has been cleared of abrasive mixture, it can be closed without damage.

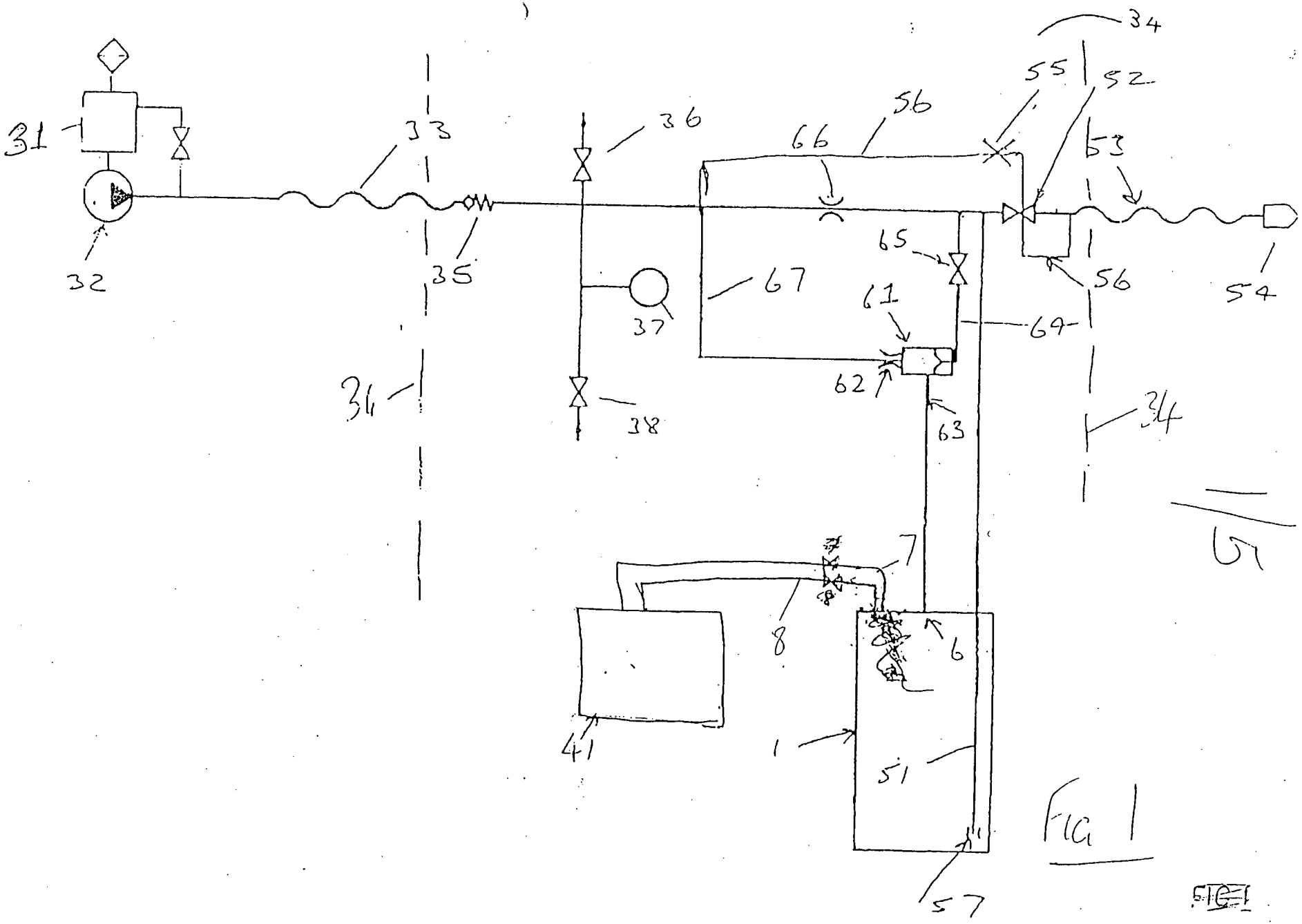
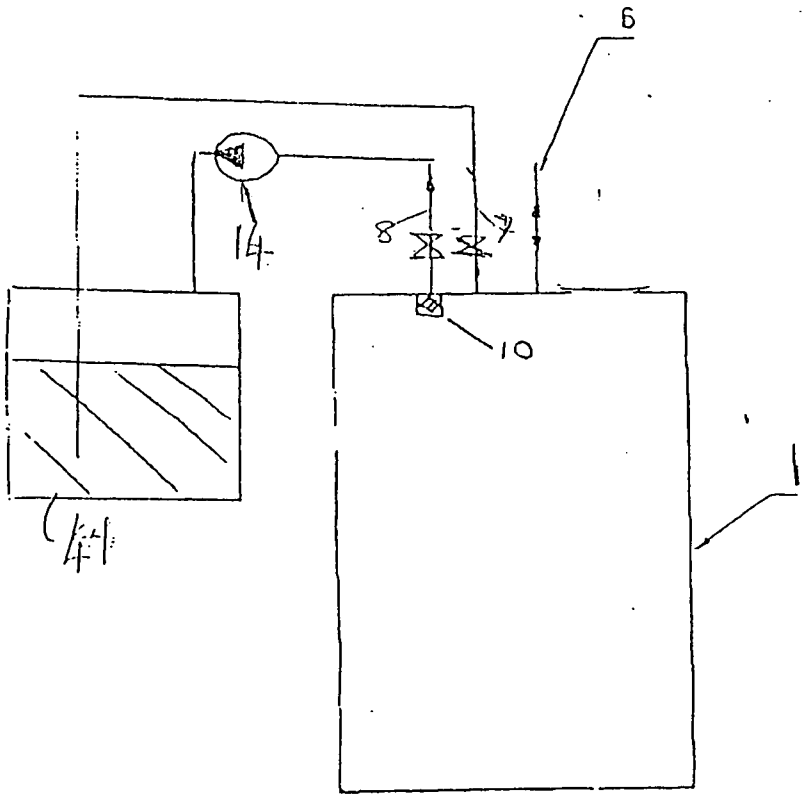
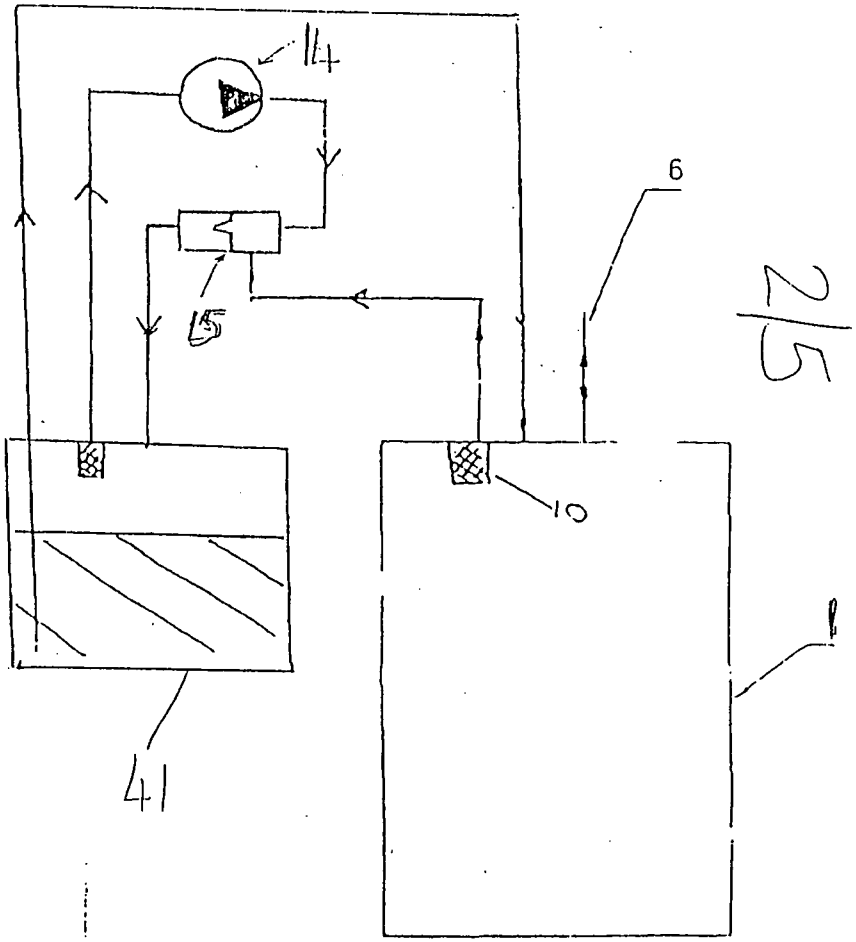

31
32
33
35
36
37
38
34
55
52
56
66
53
65
67
61
69
62
63
54
7
8
6
41
1
51
57

FIG 1

24-JUL-97 04:33P BRK GROUP LIMITED P.08



~~FIG2a~~ Fig 2



~~FIG2b~~

FIG 3

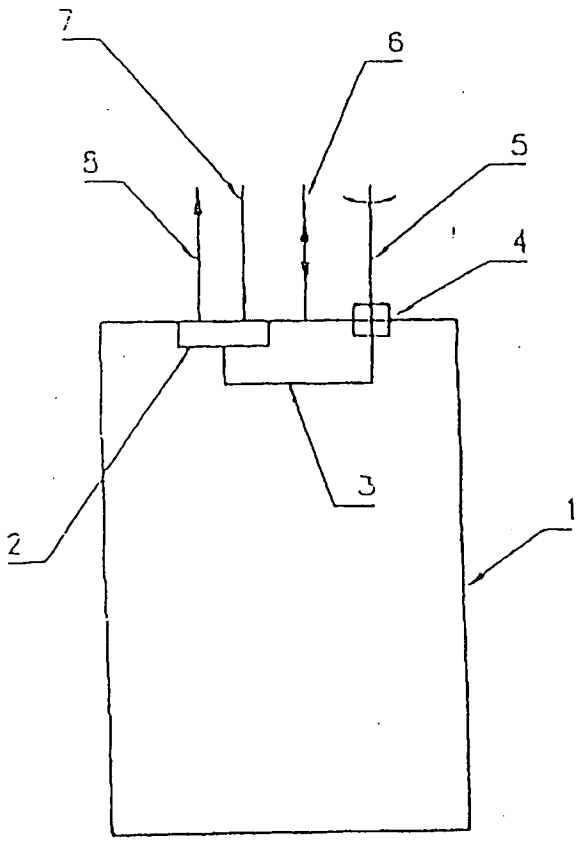
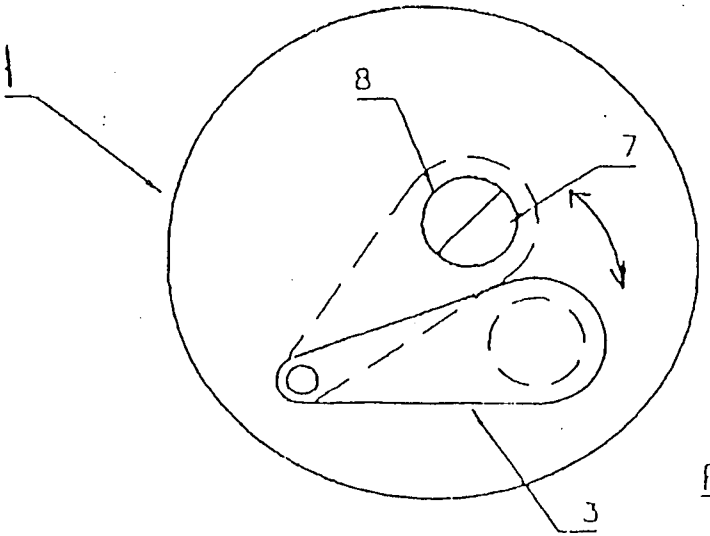


FIG 4



7a

FIG 7b

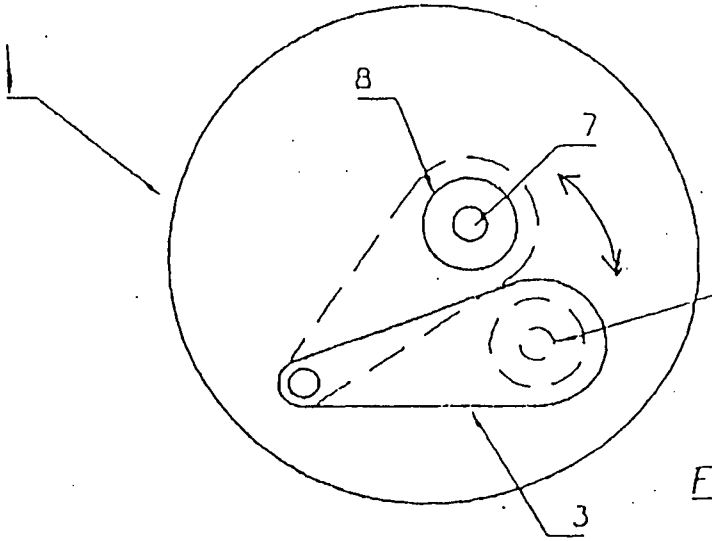


FIG 7b

3/5

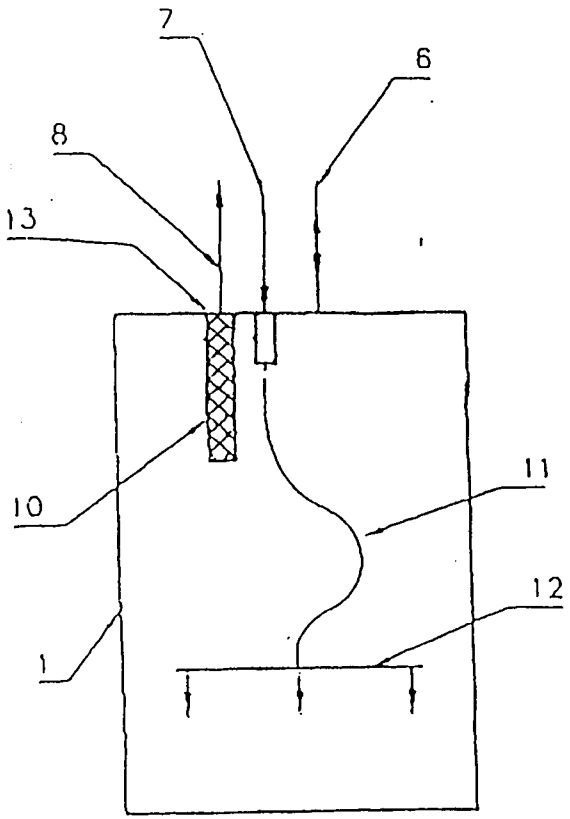
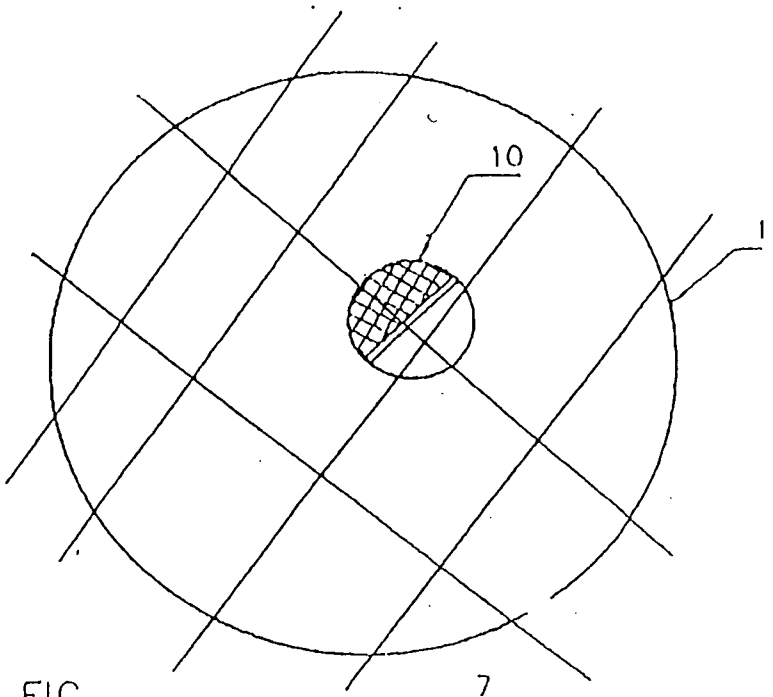


FIG 6



FIG

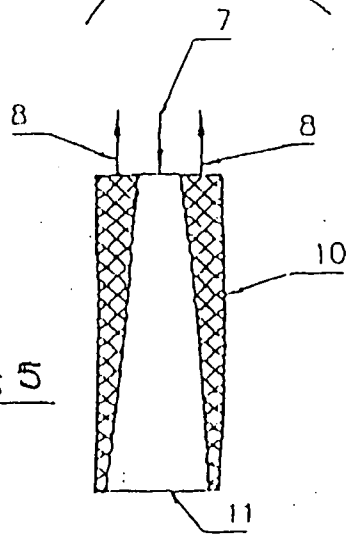


FIG 5

4/5

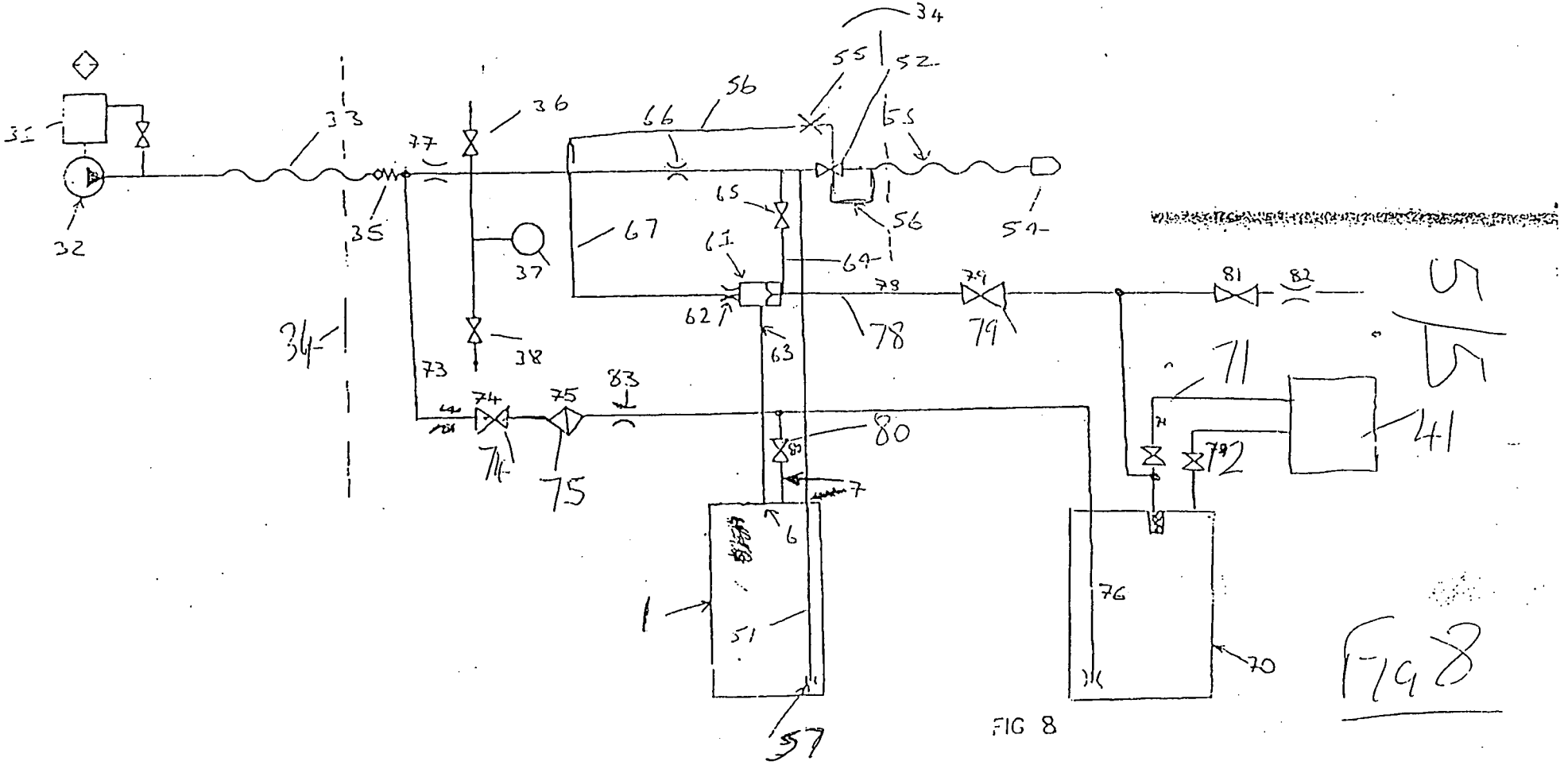

34
55
52
56
66
65
36
33
77
31
32
35
67
37
65
61
64
56
54
62
63
78
79
81
82
38
73
83
74
75
80
71
41
72
76
70
1
51
57
6

FIG 8

PG GB 9-100763
Edward Evans
9-3-00